CANAIRY ALERT
TOMORROW'S AIR TODAY

CLEAN AIR FUND

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AIR QUALITY FORECASTS USING THE NASA GEOS-CF MODEL

Christoph A. Keller

Morgan State University / GESTAR-II
NASA Global Modeling and Assimilation Office (GMAO)

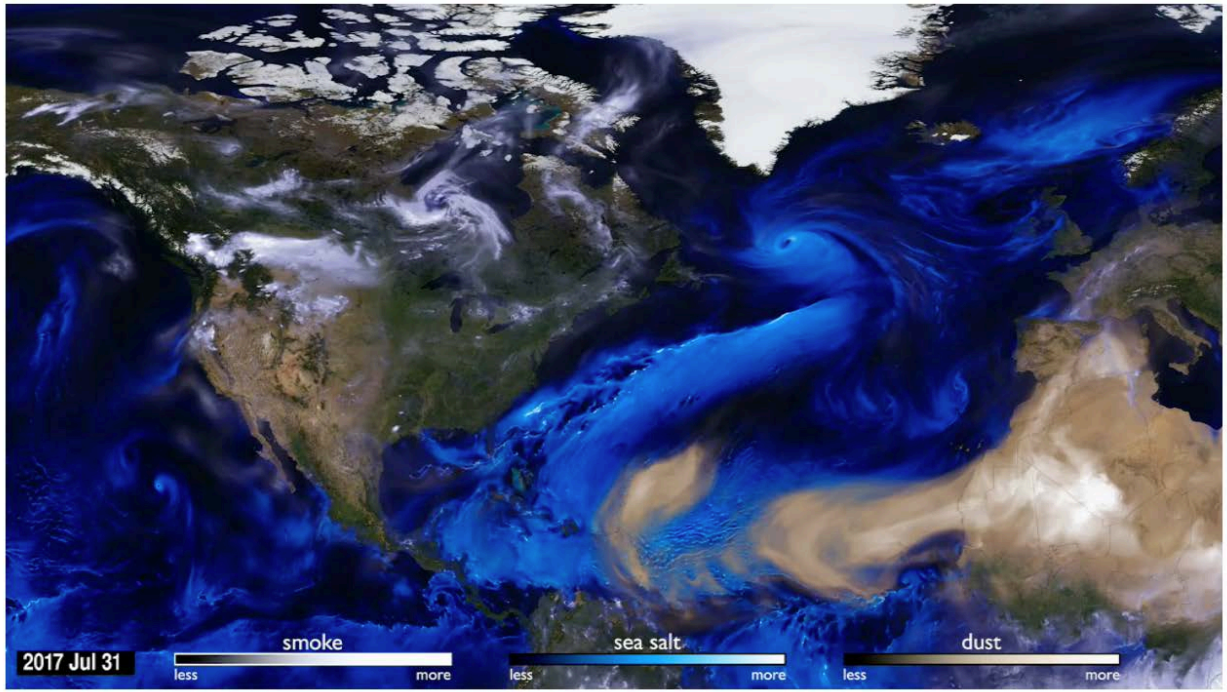
Contributions from: Emma Knowland, Noussair Lazrak, Viral Shah
In collaboration with many scientists from
NASA Goddard Space Flight Center

Nov 22, 2023

NASA

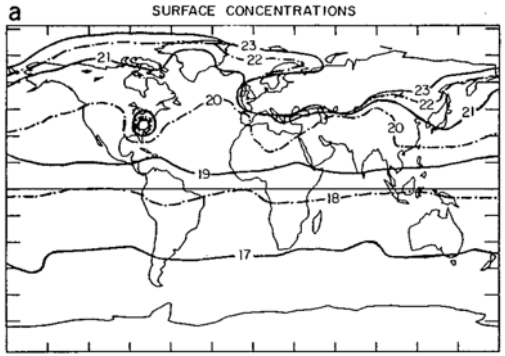
MORGAN STATE UNIVERSITY

GMAO's core mission is to enhance the value of NASA's observations to understand, analyze and predict changes in the physics, chemistry and biology of the Earth system



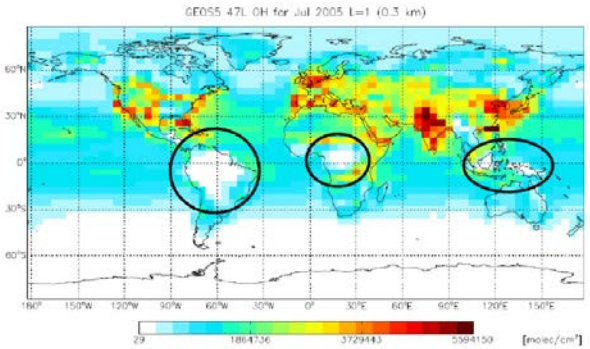
We can now simulate atmospheric composition with unprecedented level of detail

~1990



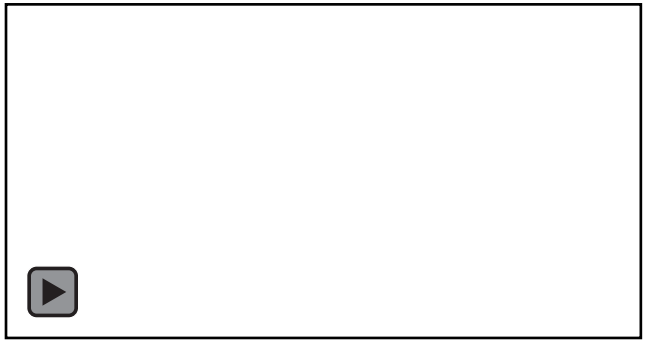
Jacob (1987)

~2005



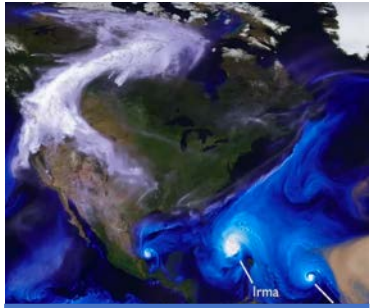
Edwards (2011)

Today

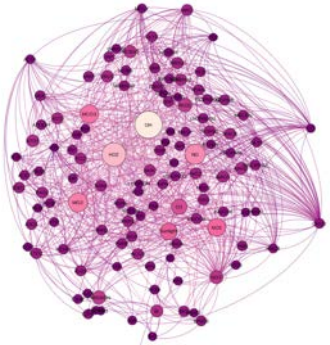


Global forecasts at:
https://fluid.nccs.nasa.gov/cf/

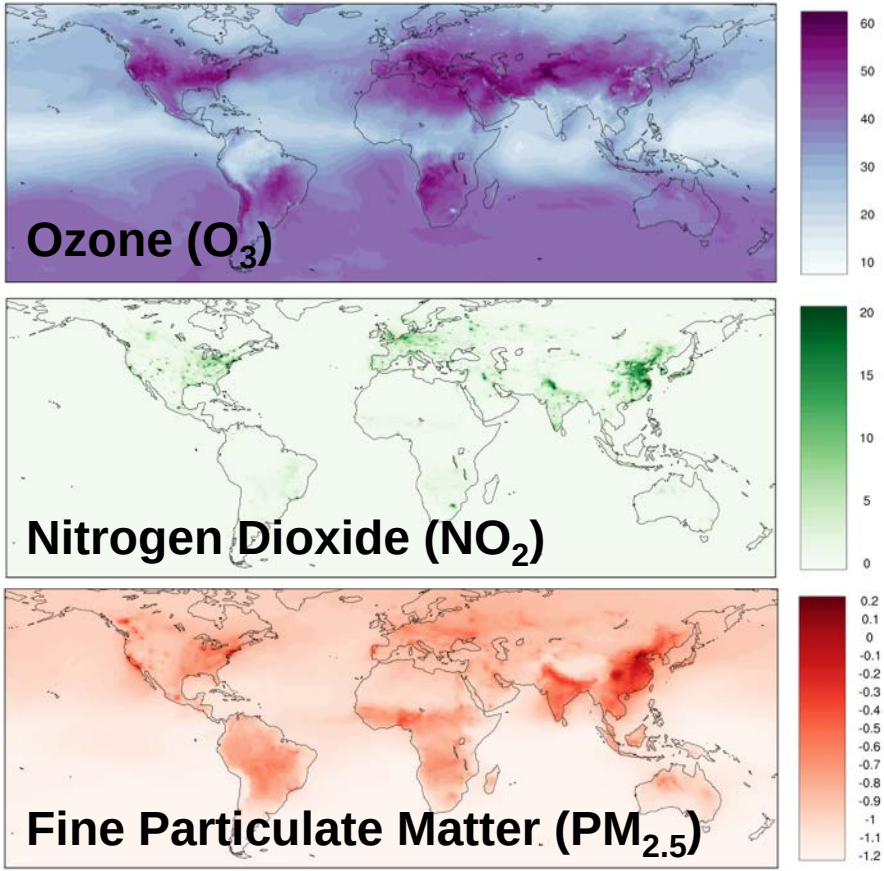
NASA GEOS composition forecast (GEOS-CF)



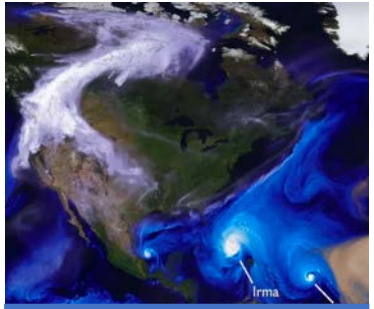
GEOS Weather



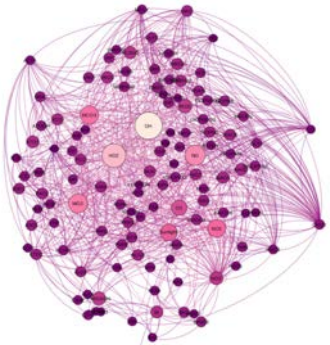
GEOS-Chem



Daily composition forecast



Weather



GEOS-Chem

GEOS - CF

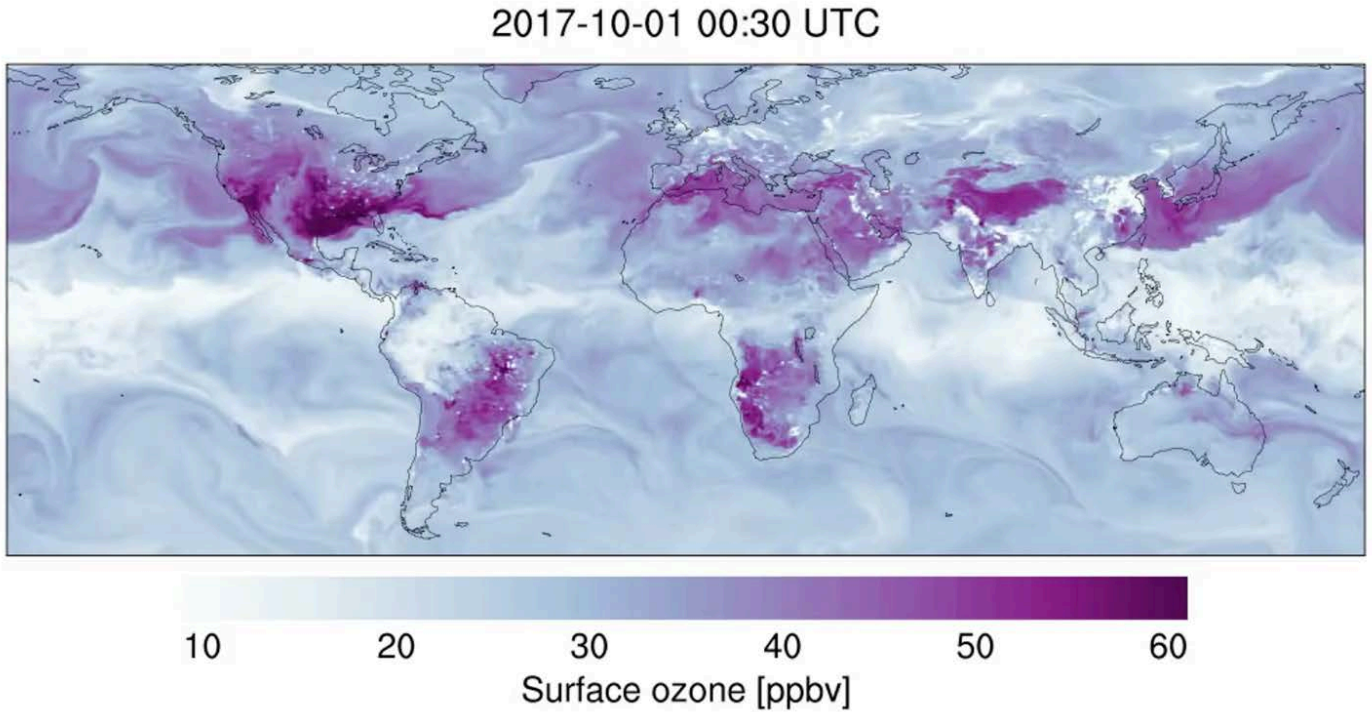
One **5-day forecast** per day

- 1-day hindcast
- 5-day forecast
- c360 (0.25°, ~**25x25 km²**) resolution, 72 model layer



3’500 computers, 6 hours!

High-resolution global simulation of atmospheric composition

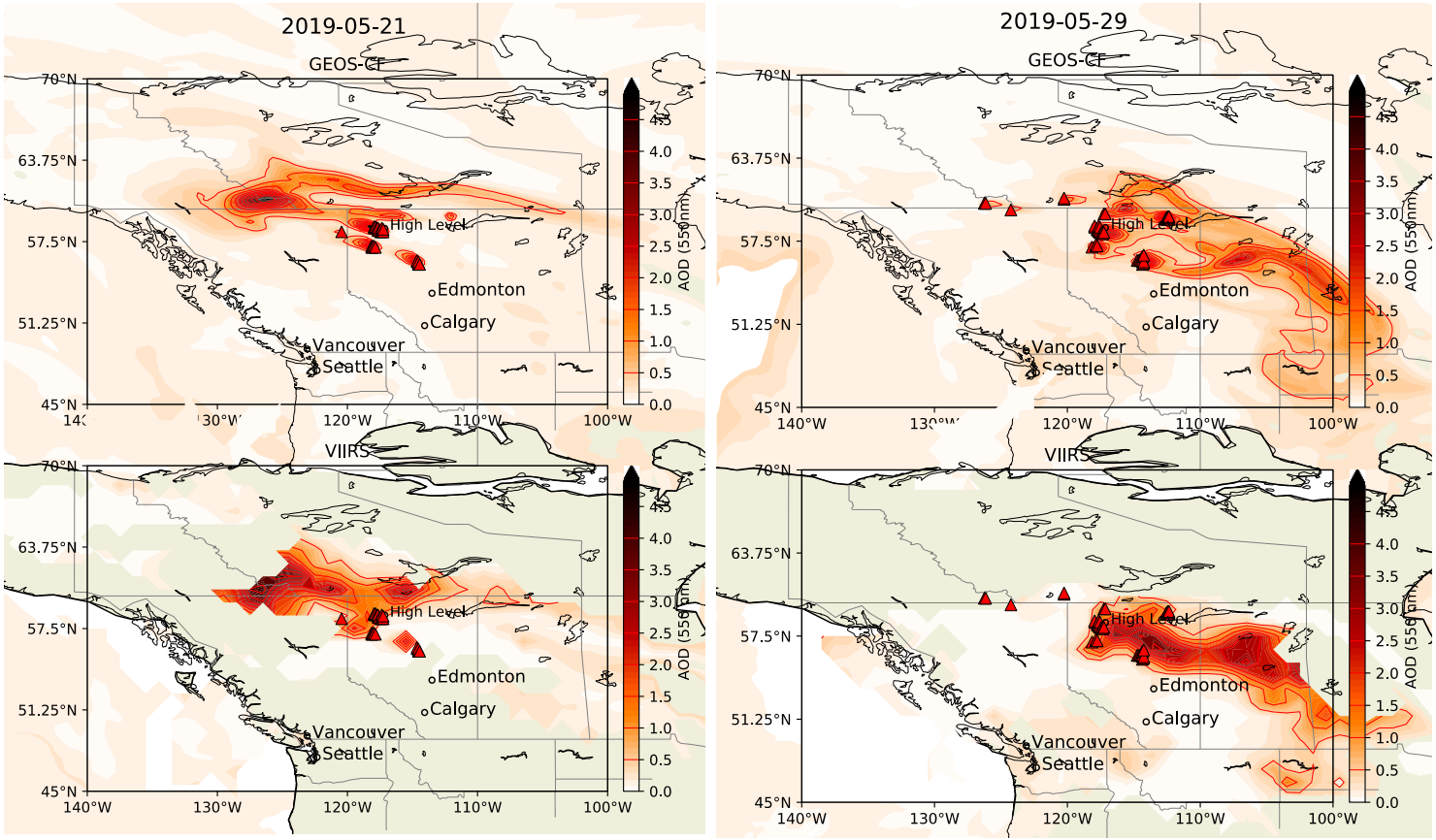


- 56 million grid cells (25x25 km^2, 72 levels), 250 chemical species
- ~3500 CPUs, 1 simulation days / hour, 1TB of output per day

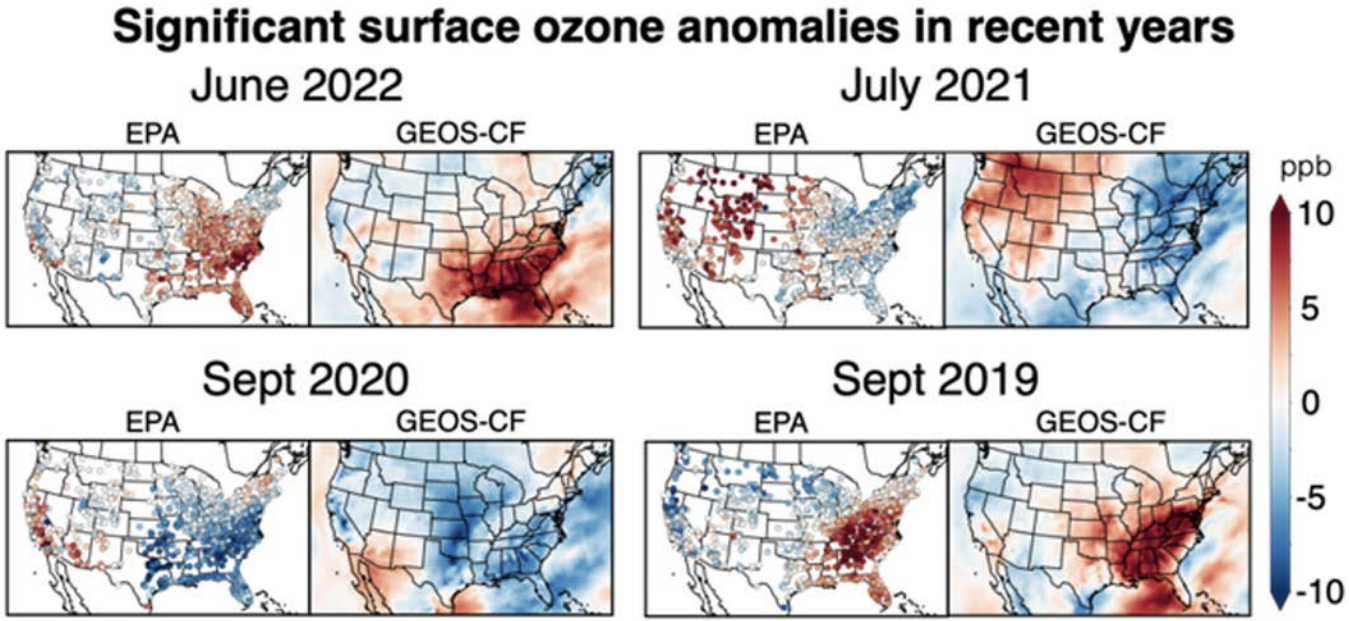
Alberta wildfires 2019

GEOS-CF

VIIRS

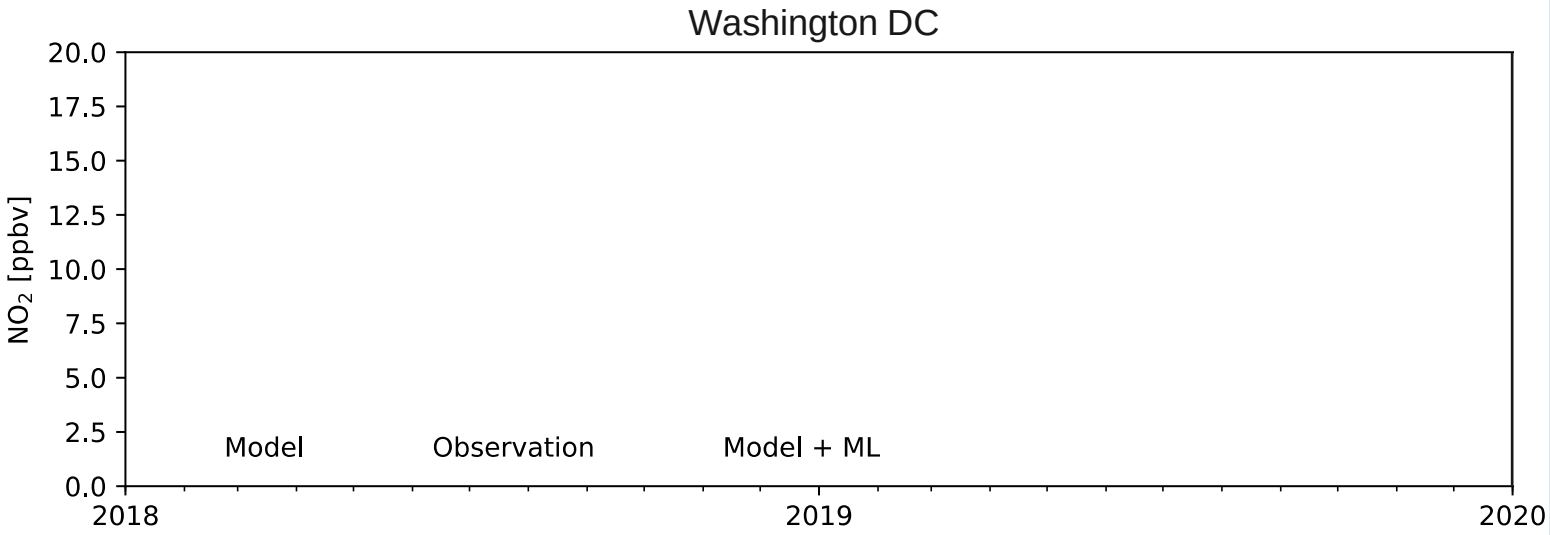


Application Example: Link Ozone Extremes to Weather Anomalies



https://gmao.gsfc.nasa.gov/research/science_snapshots/2023/ozone-2023.php

Machine learning can be used to produce bias-corrected prediction

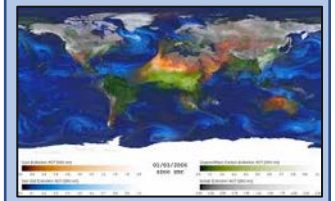


→ This method is limited to locations with (surface) observations

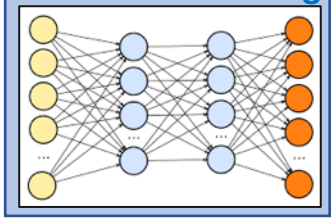
Observations



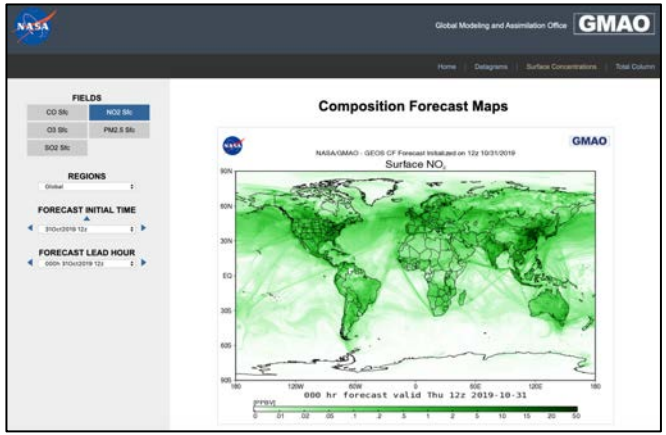
GEOS model



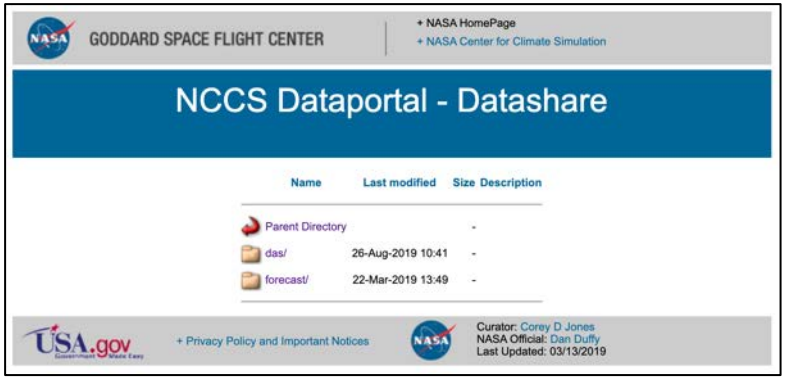
Machine Learning



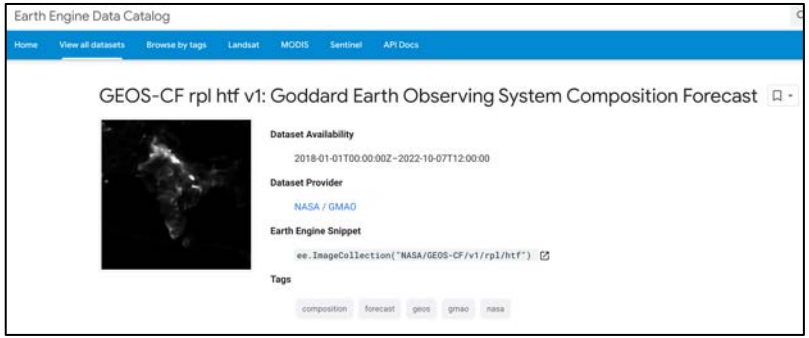
GEOS-CF model output available to the public in near real-time



https://fluid.nccs.nasa.gov/cf/



https://portal.nccs.nasa.gov/datashare/gmao/geos-cf/v1/



https://developers.google.com/earth-engine/datasets/catalog/NASA_GEOS-CF_v1_rpl_htf

GrADS Data Server - info for /gmao/geos-cf/assim/chm_tavg_1hr_g1440x721_v1 : dds das

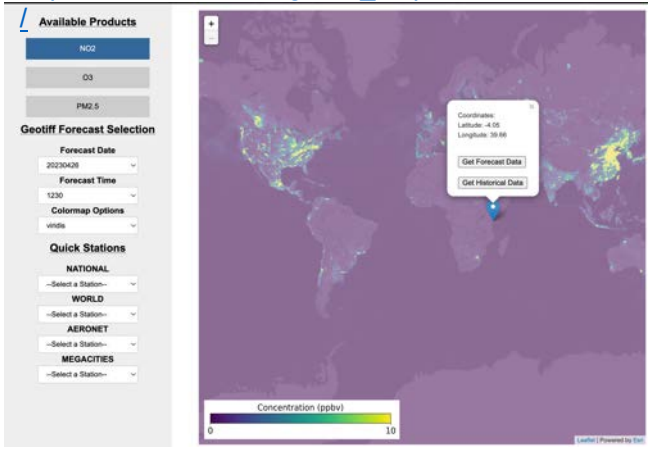
OPeNDAP/DODS Data URL: https://opendap.nccs.nasa.gov/dods/gmao/geos-cf/assim/chm_tavg_1hr_g1440x721_v1

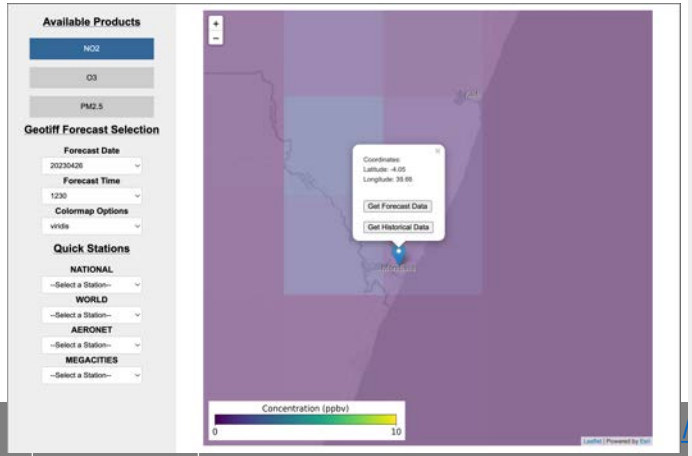
Description:	GEOS CF (Composition Forecast)	
Documentation:	(none provided)	
Longitude:	-180.00000000000°E to 179.75000000000°E	(1440 points, avg. res. 0.25°)
Latitude:	-90.00000000000°N to 90.00000000000°N	(721 points, avg. res. 0.25°)
Altitude:	72.00000000000 to 72.00000000000	(1 points)
Time:	00:30Z01JAN2018 to 11:30Z31OCT2019	(16044 points, avg. res. 0.042 days)
Variables:	**(total of 52)**	
xyle	xylene (c8h10, mw = 106.16 g mol-1) volume mixing ratio dry air	
dst2	dust aerosol, reff = 1.4 microns (mw = 29.00 g mol-1) volume mixing ratio dry air	
hno4	peroxynitric acid (hno4, mw = 79.00 g mol-1) volume mixing ratio dry air	
pm25su_rh35_gcc	sulfate_particulate_matter_with_diameter_below_2.5_um_rh_35	

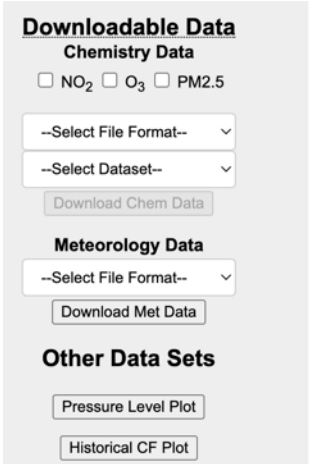
https://opendap.nccs.nasa.gov/dods/gmao/geos-cf/

GEOS-CF forecast imagery is available on-demand

https://fluid.nccs.nasa.gov/cf_map



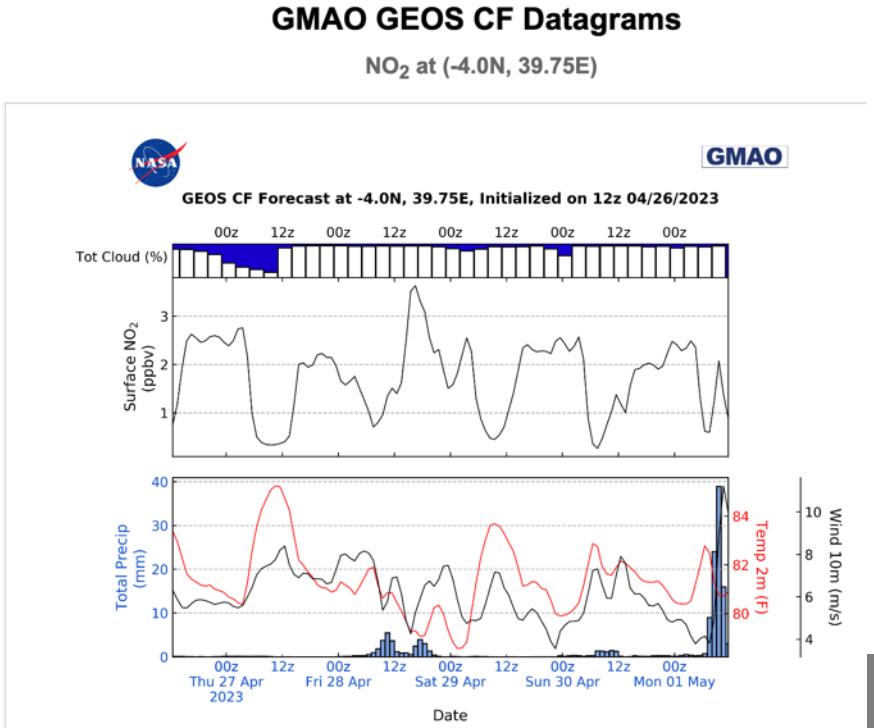




NO2

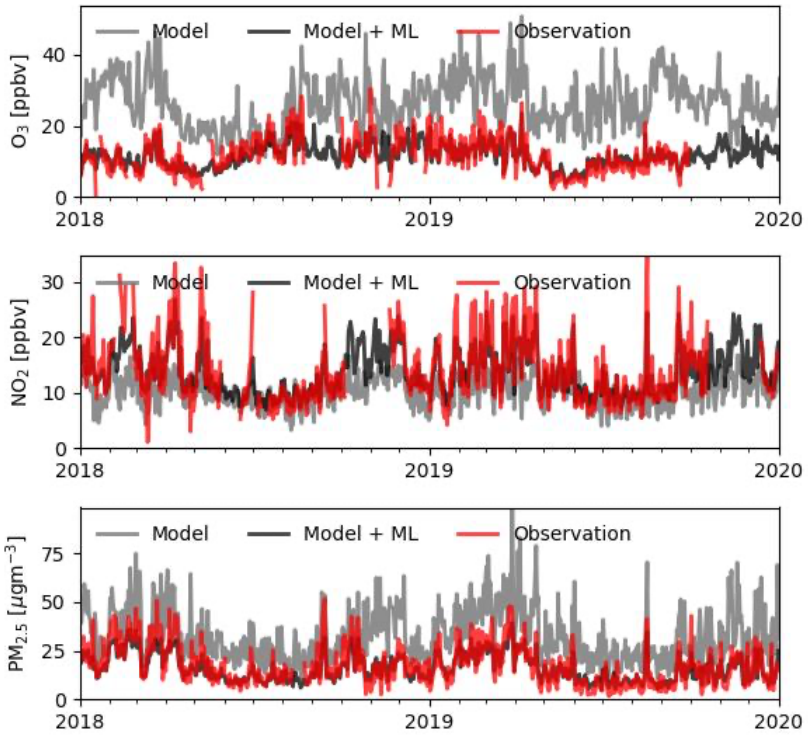
O3

PM 2.5

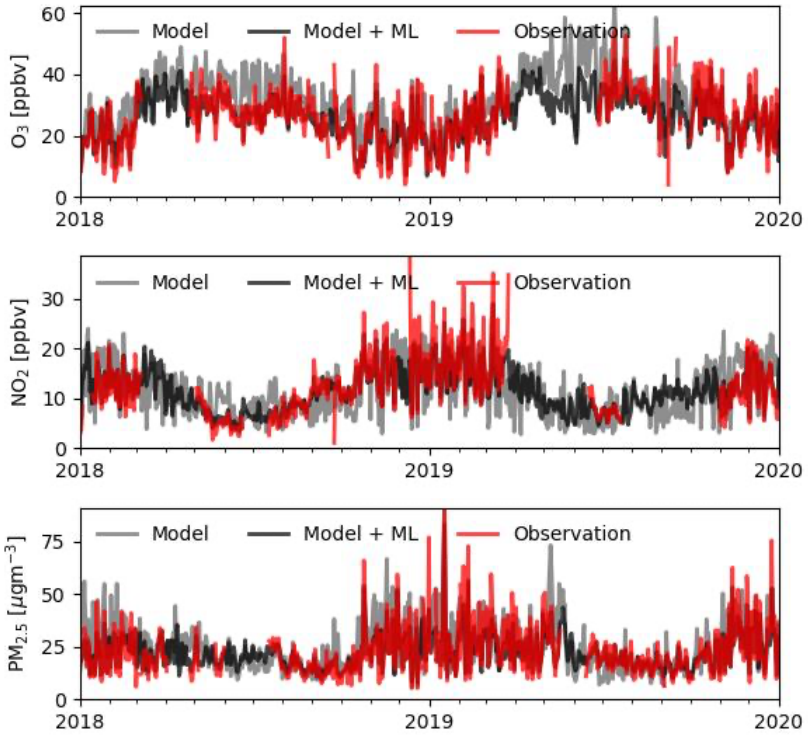


Localized forecast can be done for any location with observations

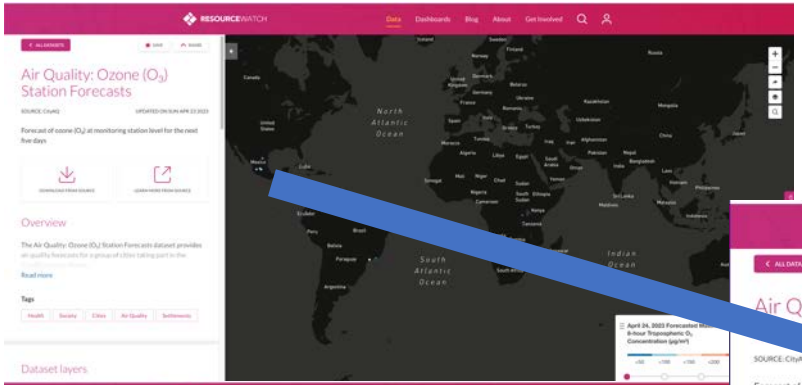
Bogota, Tunal

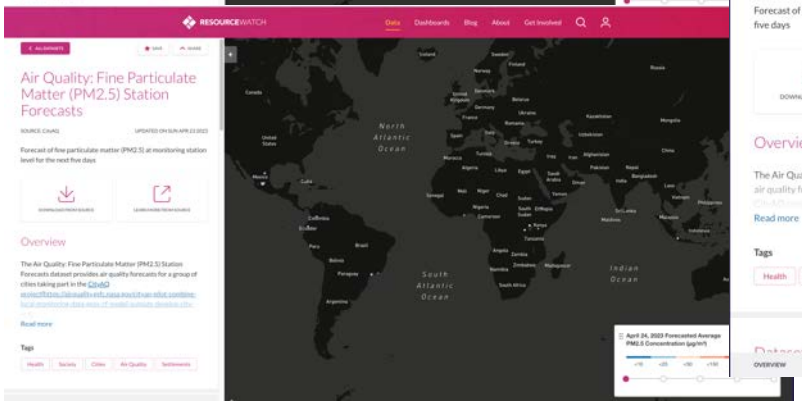


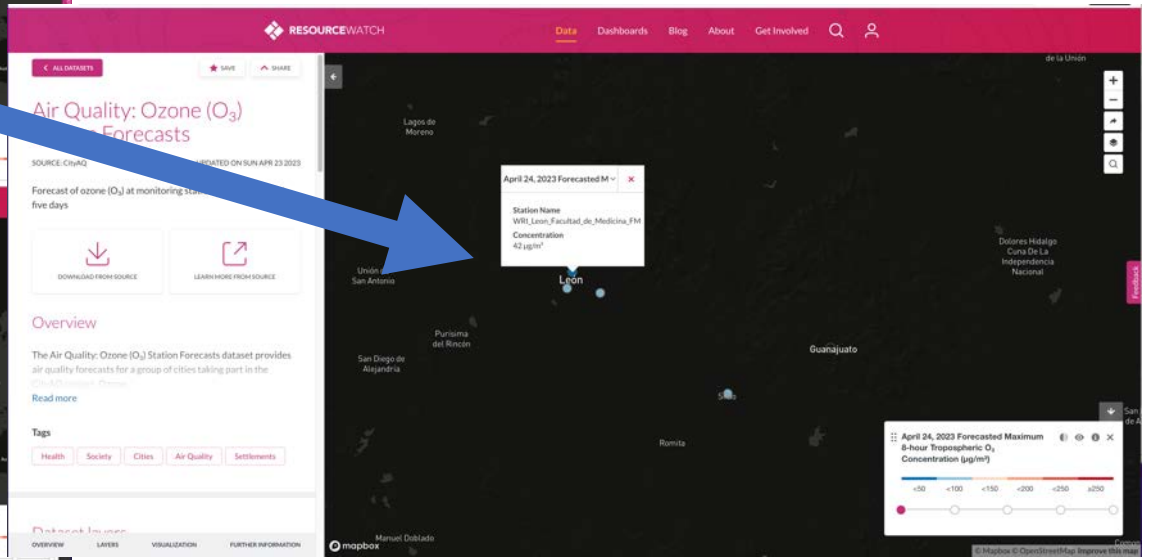
Monterrey, Obispado



Share and expand localized forecast capabilities and other downscaling techniques is a priority

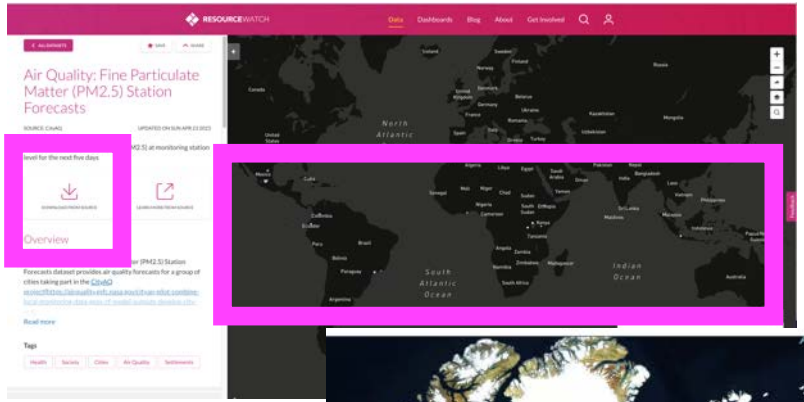


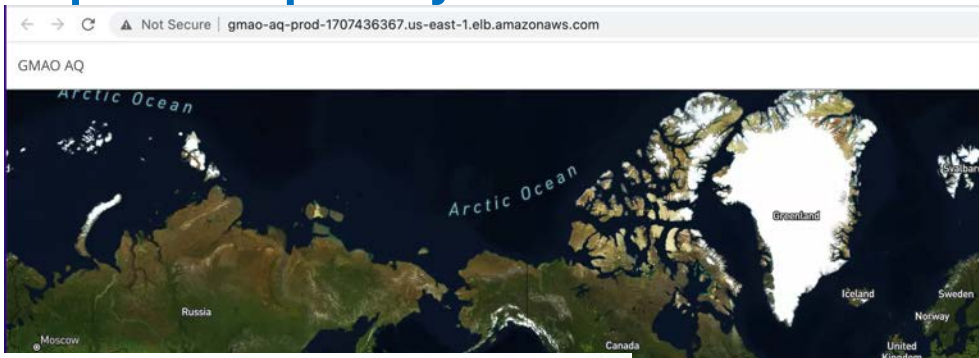


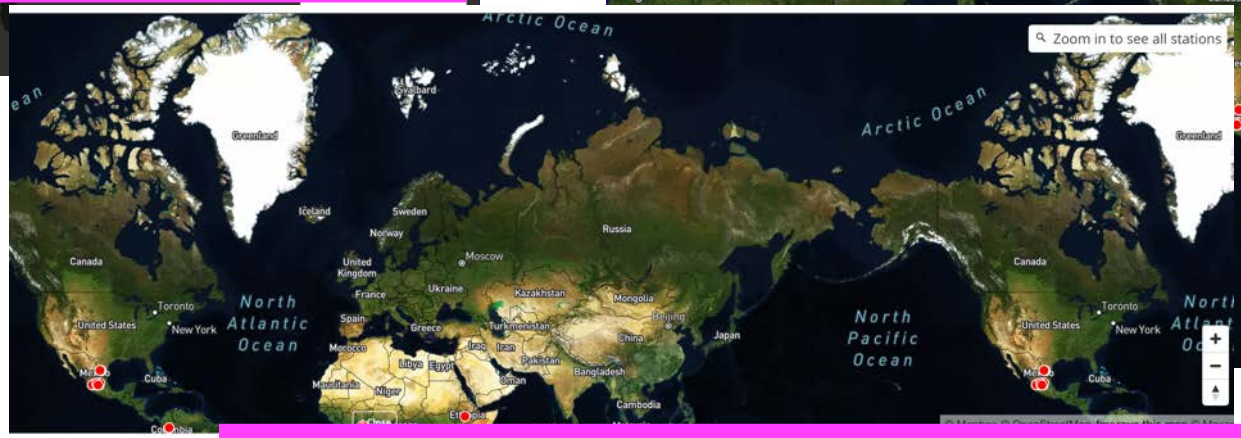


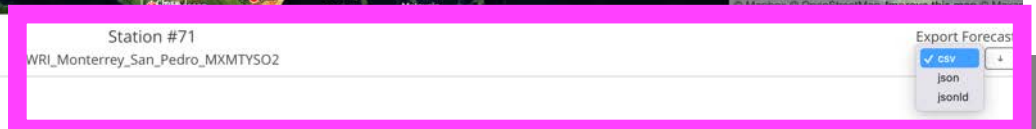
CityAQ: https://www.wri.org/initiatives/cityaq
CanAIRy: https://www.wri.org/initiatives/canairy-alert

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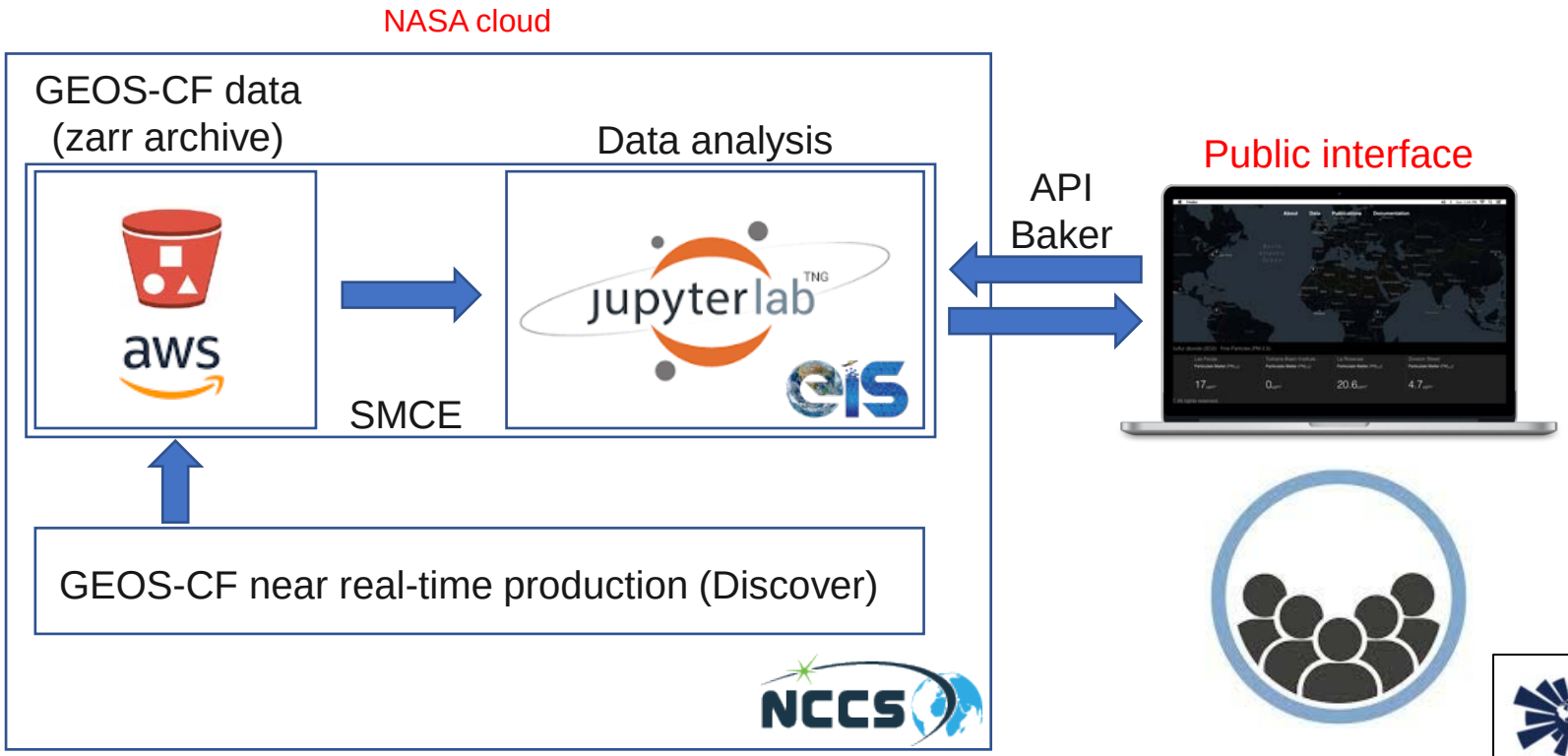








New interface to enable on-demand access to localized forecasts



Thank you!

https://gmao.gsfc.nasa.gov/weather_prediction/GEOS-CF/

christoph.a.keller@nasa.gov

